KING COUNTY CONVEYANCE SYSTEM IMPROVEMENT PROJECT

CONVEYANCE SYSTEM COST SYSTEM STORAGE FACILITY COST PARAMETERS

FINAL REPORT

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in association with

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INTRODUCTION

The purpose of this memo (originally written in 1999) is to define the parameters and unit costs used to estimate the costs for off-line storage facilities for sanitary sewer overflow (SSO) and combined sewer overflow (CSO) control. A more general discussion of the purpose of the overall cost system is included in the September 2001 *Conveyance System Cost Estimates – Task 250 Report.*

COST MODEL

The model will be structured to provide the user with a formatted means of data entry and a formatted output for incorporation into other cost estimating models. The relationship between the scope of this work and other cost models is detailed in the Figure 1.

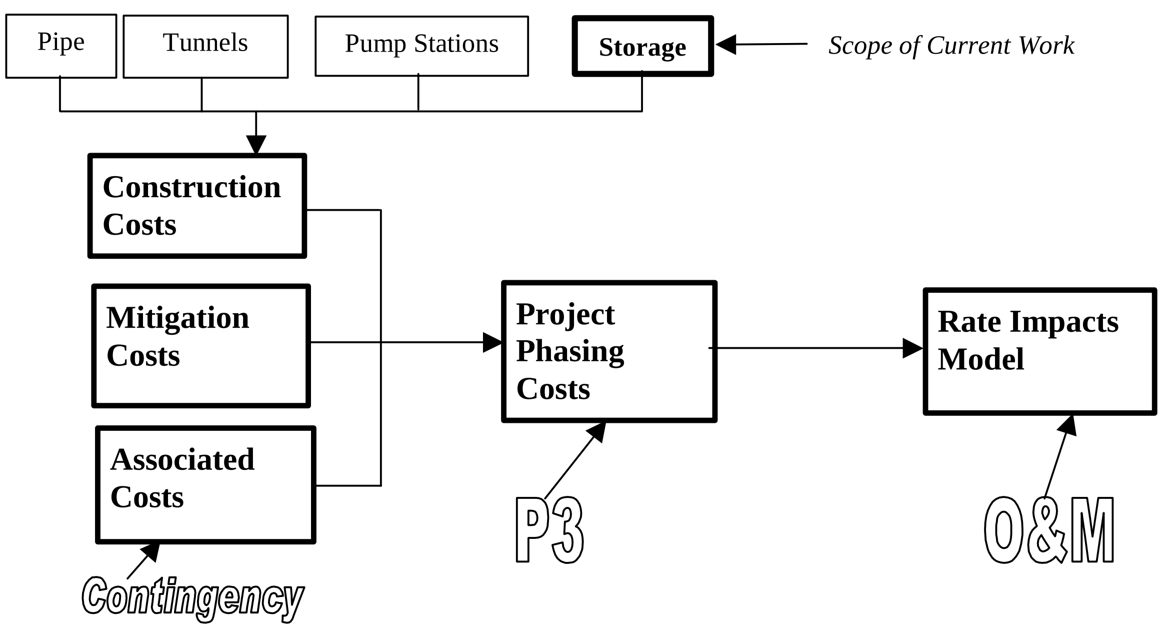


Figure 1. Cost Development Relationships

OFF-LINE STORAGE FACILITIES

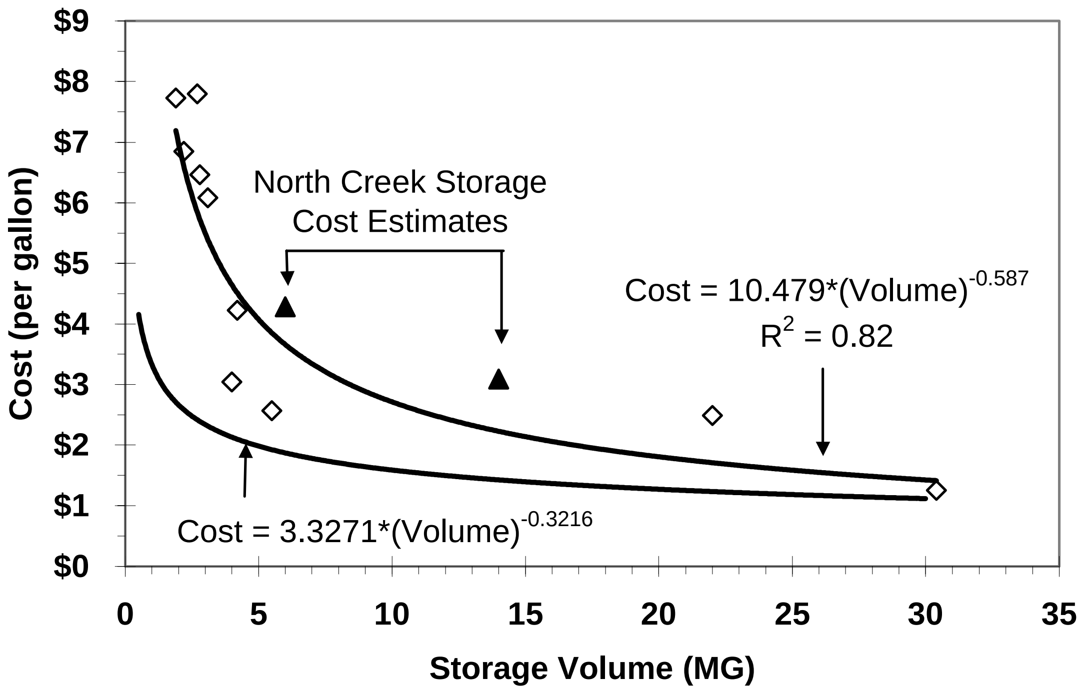
Cost curves were developed for off-line storage facilities from previous project costs and updated cost curves (Figure 2). The off-line storage/treatment facilities in Michigan used to develop the upper cost curve in most cases include screening, facility flushing equipment, dewatering by pumping, and odor control equipment. Since KCWTD facilities will most likely include similar equipment, the upper cost curve should be used for initial cost estimates. The items that are included in the base cost estimate include:

- Structural costs,
- Excavation, haul, and backfill,
- Shoring,
- Storage facility cleaning equipment, and
- A diversion structure.

Variable costs are defined outlined in the following section and include:

- Land acquisition,
- Dewatering,
- Means of filling the facility (gravity or pumping),
- Means of emptying the facility (gravity or pumping),
- Relocation of existing utilities, and
- Odor control facilities.

The upper cost curve in Figure 2 was developed based on the construction costs for a number of recently constructed CSO detention facilities in Michigan. Wastewater is usually conveyed to these facilities by gravity. Following the peak flow event, the facilities are then pumped out. These facilities also typically include wet-scrubber odor control systems and probably involved some dewatering. Therefore, the cost database system will either add or subtract costs from the baseline curve in Figure 2 depending upon the options selected by the user.



User Input Parameters

The model is configured to allow for a variety of site conditions by adjusting certain input parameters. These project specific input parameters and the default values are summarized in Table 1.

Table 1. Project Specific Input Parameters

Parameter	Options	Default
Storage Facility Name	User must storage facility name	Must be input by user
Construction Year	User may select future construction year	Current Year
Storage Capacity	2-30 million gallons	Must be input by user
Dewatering	None; Standard; Significant	Standard
Odor Control	Yes/No	No
Operations	Gravity In and Gravity Out; Gravity In-Pump Out; Pump In – Gravity Out	Gravity In – Pump Out
Land Acquisition Required	None; Residential; Industrial; Commercial	None
Land Acquisition (Square Feet)	User must input a value	0
Surface Restoration	None; Hydroseed; Pavement	Hydroseed
Unique Construction Costs	User must input a cost number and describe unique construction cost items	0

In some cases, there will be construction costs that are unique to a given project. These costs may include special surface restoration requirements, artwork, odor control facilities, and other miscellaneous construction costs. To account for these costs at the planning stage, the user will be allowed to input a fixed dollar amount that will be calculated separately by the user with a box for noting what the additional costs include.

Dewatering

Dewatering can be a significant portion of storage facilities costs given the size and depth of these facilities. In most cases, the storage facilities will be located below the invert of nearby gravity sewers to allow the facilities to fill by gravity. This depth may result in significant dewatering operations since the bottom of the facility could be many feet the groundwater table. For planning purposes, dewatering costs, both equipment set-up and dewatering operations, were estimated based on the proposed facility volume. The equations used to determine dewatering costs are:

$$\text{Standard Dewatering Cost (\$)} =$$
$$750 \times [\text{Storage Volume (Mgal)}]^2 + 36{,}500 \times [\text{Storage Volume (Mgal)}] + 340{,}000$$

$$\text{Significant Dewatering Cost (\$)} =$$
$$1{,}000 \times [\text{Storage Volume (Mgal)}]^2 + 68{,}500 \times [\text{Storage Volume (Mgal)}] + 650{,}000$$

In this context, “standard” dewatering costs should be used for storage facilities where the groundwater table is below the top of the storage facility and the soils are silts or clays that have a relatively low permeability. Where the soils include sands or other permeable soils and/or the water table is above the top of the storage facility (or within a few feet of the ground surface), “significant” dewatering should be selected. Example costs for dewatering are shown in Table 2.

Table 2. Example Dewatering Costs

Storage Volume (Mgal)	Standard Dewatering Cost[1]	Significant Dewatering Cost[1]
2	$416,000	$791,000
4	$498,000	$940,000
6	$586,000	$1,097,000
10	$780,000	$1,435,000
20	$1,370,000	$2,420,000

Notes:
(1) Costs based on ENR Seattle CCI = 7,137 for December 1999.

Odor Control

Odor control may be required when the storage facility is located near residences or parks. For planning purposes, it was assumed that the odor control equipment installed would be capable of ventilating an empty storage facility at 2 air changes per hour (ACH). Based on this parameter, the costs of odor control systems could be estimated with the formula:

$$\text{Odor Control Cost (\$)} = 126{,}000 \times [\text{Storage Volume (Mgal)}] + 10{,}000$$

This equation was developed based on capital cost curves for non-impregnated activated carbon developed by Gravette et al (1989). These capital costs include the installed cost for all the odor control equipment, as well as appurtances associated with the equipment (fans, ductwork, electrical, instrumentation and control). The calculated capacity and costs for odor control units for various storage volumes are shown in Table 3. Additional costs will be incurred if the equipment must be housed within an enclosed structure for aesthetic concerns.

Table 3. Odor Control Facility Sizes and Cost

Storage Volume (Mgal)	Capital Cost[1] ($)
2	$260,000
4	$520,000
6	$770,000
10	$1,270,000
20	$2,530,000

Notes:
(1) Costs based on ENR Seattle CCI = 7,137 for December 1999.

Operations

There are three potential operational scenarios for storage facilities. The scenarios are dependant upon the site topography of the proposed storage facility and the hydraulic relationship between the proposed storage facility and associated conveyance facilities. These operational scenarios include:

- Gravity in and gravity out,
- Gravity in and pump out, and
- Pump in and gravity out.

Ideally, any storage facility would be designed to fill and empty by gravity. However, this operational scenario will not be practical in most cases. It will be more common to fill the storage facility by gravity and pump it out after peak flows in the system subside. For planning purposes, it was assumed that the storage facility pump station would be designed to pump out the entire storage volume in 24 hours. Furthermore, it was assumed that wet-pit submersible pumps would be used, which minimizes the electrical and structural costs associated with the pump stations. These pump stations are acceptable in this situation since the reliability of the pump station is not critical and the pump station would only be used intermittently. The cost for effluent pump stations was developed based on reviewing conceptual designs for similar facilities. From this review, the following equation was developed:

$$\text{Effluent Pump Station Cost}\left(\$\right) = 1.15 \times \left\{22{,}000 \times \left[\text{Storage Volume}\left(\text{mgd}\right)\right]^{0.85} + 120{,}000\right\}$$

Table 4 includes the estimated costs for an effluent pump station based on this equation.

Table 4. Effluent Pump Station Costs

Storage Volume (Mgal)	Pump Station Cost[1]
2	$184,000
4	$220,000
6	$254,000
10	$317,000
20	$461,000

Notes:
(1) Costs based on ENR Seattle CCI = 7,137 for December 1999.

Where it is not practical to fill the pump station by gravity, an influent pump station will be required. For planning purposes, it is assumed that an influent pump station would be more similar to the pump stations outlined in the September 2001 *Conveyance System Cost System – Pump Station Cost Parameters* complete with a standby generator, an odor control unit, separate wetwells and drywells, and variable frequency drives. The cost of gravity lines to the pump station and force mains from the pump station are included in the base cost for the facility. Thus, if a “pump-in” option is selected, then the system should refer the user to the pump station cost module for further information.

Outputs

The output from the model will summarize the input parameters and model outputs in a spreadsheet format that can be exported into other King County cost model components.

References

Gravette, B., T. Card, K. Hood. 1989. An Overview of Odor Control Systes. 1989 Pacific Northwest Water Pollution Control Association Conference. Eugene, OR.